Chapter 6 – Cumulative

in strategic environmental assessment report

(SEA 2007 report – US)

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Prepared
in connection with the aluminum project
by the Greenland Home Rule
SEA working group

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1 SUMMARY

1.1 Introduction

The Greenland Home Rule has contracted an alliance with the American aluminium company Alcoa Inc. on the study of possibilities of constructing an aluminium plant with a production capacity of 340,000 tonnes per year, and associated hydropower plants. This study will constitute the basis for the final choice of location and construction of the specific elements of the project.

As part of the study the Department of Environment and Nature, Greenland Home Rule, conducts a Strategic Environmental Assessment (SEA) of the alternative locations for the aluminium plant and associated hydropower plants. For the area west of Maniitsoq Iskappe between Nuuk and Sisimiut (see Appendix 2), the SEA is carried out in four separate main themes: Environment and Nature, Health, Regional Development and Culture. Final reports will be produced for each theme at the end of the assessments.

In addition to the four main themes of the SEA, Grontmij | Carl Bro a/s has conducted a preliminary cumulative assessment of the planned hydropower plant at Lake Tasersiaq for Department of Environment and Nature. This cumulative assessment covers the area between Evighedsfjorden, Søndre Strømfjord and the Sarfartoq River (see Appendix 3). The aim of this assessment is to assess the cumulative impact of the hydropower plant and all other known and planned activities in the area, such as mineral exploitation and tourism, as the area is of great interest for such activities.

Four alternative locations of the hydropower plant and headrace tunnels from Tasersiaq have been proposed; named 07.e-1, 07.e-2, 07.e-3, and 07.e-4 in the statement of Nukissiorfiit on the hydropower potential in Greenland (see Appendix 3).

The location 07.e-2 has been excluded by Department of Environment and Nature due to its position in the protected Paradise Valley/Arnangarnup Qoorua. The present assessment therefore only includes the two northern locations at Sarfartoq Qoorua (07.e-1 and 07.e-4) and the southern location at Ujaraannaq/Evighedsfjorden (07.e-3).

According to Greenland Home Rule a harbour is planned for construction in Søndre Strømfjord at the mouth of Sarfartoq River independent of whether a northern or southern location is chosen for a hydropower plant.

1.2 Material and methods

Usually, a cumulative SEA would be conducted on the basis of data and assessments from the final reports of the four, above mentioned, themes. However, the current cumulative assessment has been conducted in parallel with the four other assessments, from which data and assessments have been extracted for the cumulative assessment. This procedure is not ideal, but has been necessary due to the deadlines of the entire SEA process. Consequently, this resulted in the cumulative SEA being conducted without the latest data and final conclusions and assessments from the four SEAs on Environment and Nature, Health, Regional Development and Culture.
The cumulative analysis has therefore been conducted on the basis of existing knowledge extracted from available literature, reports and GIS data, together with information obtained during meetings with relevant departments in the Greenland Home Rule, Greenland Institute of Natural Resources, Asiaq a/s, Nukissiorfiit, Greenland Development, National Environmental Research Institute (NERI) and the National Museum.

Furthermore, assessments of impacts on nature have been coordinated with NERI, the official advising body on natural resources to the Greenland Home Rule. This coordination was carried out to ensure that the assessments in the current document reflect contemporary assessments of NERI.

The assessment of potential human impact on archaeological remains has likewise been sent to the Greenland National Museum for comments.

All relevant parameters and potential impact of a hydropower plant, mineral activities, hunting and tourism on these parameters are listed in Appendix 1. The impact on each parameter is assessed as: none (0), low (1), moderate (2) or significant (3). All parameters with a moderate or significant impact assessment are discussed in the text together with possible mitigations.

1.3 Assessments

The cumulative SEA has identified the following parameters as potentially facing moderate to significant effects by one or more of the current and planned activities in the area. Further analyses and documentation of effects or operational monitoring programmes forming baselines for mitigation may be required in cases where significant problems are envisaged to arise.

Caribou and muskox are affected by hydropower plant, mineral activities, hunting and tourism.

The impact is mainly ascribed to increased disturbance from hunting and tourism as improved infrastructure associated with hydropower plant and mineral activities facilitate access to currently more or less undisturbed areas. Data indicate that populations of muskoxen in the area currently are close to carrying capacity. It has therefore been suggested that population dynamics may change in the near future, which in return will affect to which extent increased disturbance and hunting will affect the population.

Construction of buildings and infrastructure associated with the hydropower plant and mineral activities, as well as increased air traffic, hunting and recreational activities in the area may result in increased disturbance on both caribou and muskox.

Construction of buildings and infrastructure during the construction phase may influence the distribution of caribou and muskox in the area. However, animals will probably return to disturbed areas when construction work is completed, as long as human activities associated with operation of the plant are limited. Flying at low altitudes with airplanes and helicopters, and increased hunting and recreational activities in the area may on the other hand have long-term effects on caribou and muskox.

Additionally, construction of transmission lines, a harbour and infrastructure may potentially affect dispersal routes of both caribou and muskox.

Harbour seal is limited in numbers in Greenland and is red-listed in Greenland. Søndre Strømfjord is home of one of the few and most northern populations on the central part of the Greenlandic west coast. A haul-out site for harbour seals earlier existed at the mouth of the Sarfartoq River. The seals were believed to abandon this haul-out site due to intense hunting and disturbance by boats.

Currently, there is a haul-out area for harbour seal at the sand delta of the Watson River close to the Kangerlussuaq airport. Harbour seals thus still occur in the Søndre Strømfjord area, and the formerly used haul-out site at the mouth of the Sarfartoq River may, if left undisturbed, be utilised by seals in the future.

Regarding the small population size of harbour seal in the fiord, increased shipping on Søndre Strømfjord due to construction and operation of hydropower and mineral activities may be critical for the population, since even a single oil spill may lead to severe mortality in the population. Additionally, construction of a harbour near the previously used haul-out site at the mouth of the Sarfartoq River may prevent the population in Søndre Strømfjord from expanding in size from its current critically low level.

Greenlandic white-fronted goose: This subspecies is of special concern in Greenland, as all its breeding grounds are located in the country. Consequently, negative impact of a hydropower plant on the Greenlandic white-fronted geese should be avoided, if possible.

Current data indicate that white-fronted geese are most vulnerable to disturbance on their spring staging areas. Construction and operation of the hydropower plant may result in disturbance on the spring staging areas due to construction of infrastructure, increased air traffic and increased recreational activities by workers associated with the plant. In addition to human activities related to the hydropower plant, mineral prospecting and exploitation will result in cumulative disturbance effects on the staging geese.

The geese are also vulnerable to disturbance during their post-breeding moult. Moulting is highly energy demanding and the geese are therefore dependent on undisturbed foraging during this period. Surveys are needed to determine whether/to which extent moulting areas occur within the area, as such data are presently not at hand.

Harlequin duck is limited in numbers in Greenland and is categorised as ”near threatened” according to the Greenlandic red list, and breeding sites should therefore be protected. The harlequin duck is assumed to breed in the Paradise Valley, but no systematic investigation has been carried out.

During the breeding season, the harlequin duck is vulnerable to disturbance from traffic near nesting sites and from airplanes and helicopters flying at low altitudes. Independent of the location of the hydropower plant, the power plant project will create increased access to the Paradise Valley through an access road from the harbour at the mouth of the Sarfartoq River.

The influx of silt from Tasersiaq to the Sarfartoq River will cease if the hydropower plant is located at Evighedsfjorden. This may improve the breeding conditions for harlequin ducks, since a larger part of the river system will become silt free. A northern location of the power plant at 07.e-4 will also lead to a larger part of the Sarfartoq River clearing up as the influx of silt ceases.

Thick-billed murre and kittiwake breed within or in the vicinity of the study area in Evighedsfjorden. Thick-billed murre breeds in the outskirts of the study area but is included in the cumulative analysis since the Greenlandic population is declining, and Greenland has agreed to contribute to the monitoring and conservation of the arctic population of thick-billed murre. The population of kittiwakes within the study area is also vulnerable, since it is declining and a large part of the Greenlandic population (ca 1/3) breeds within Maniitsoq municipality.

Gulls and auks breeding in colonies are vulnerable to oil spills near their colonies, and spills may extirpate large parts of local breeding populations. Hydropower plant, mineral activities and tourist ships may all pose a potential risk for oil spills. Among the alternative locations of the hydropower plant, the southern power plant will pose the greatest risk of oil pollution, since this location will entail increased shipping on Evighedsfjorden. The risk of oil spills given a northern location of the power plant will, on the other hand, only affect Søndre Strømfjord and associated water systems, where no breeding colonies of gulls and auks currently are found. The risk of an extensive oil pollution may, however, be regarded as minimal if the international standards for shipping operations and the current regulations for handling of oils at sea are adopted.

Arctic char is common in lakes and rivers within the study area. The River Arnangarnup running through the Paradise Valley is home to a large population of arctic char that is important to local fishermen and to the angling tourism.

The course of the Sarfartoq River will be altered by damming Lake Tasersiaq in order to form a water reservoir for hydropower. If the power plant is located to the north, the water flow from Tasersiaq to the Sarfartoq River will be led through headrace tunnels. However, if the power plant is located at Evighedsfjorden, the water from Tasersiaq to the Sarfartoq River will cease more or less completely. The supply of silt from Tasersiaq to the Sarfartoq River will thus cease if the plant is located at Evighedsfjorden, and the Sarfartoq River will consequently attain low turbidity during its entire watercourse, but maintain a reduced water level.

The altered watercourse of the Sarfartoq River will affect its flora and fauna, but the extent of the impact and whether the effect will be mainly positive or negative is uncertain. Independent of the location of the power plant, the water level in the Sarfartoq River will probably still be sufficient to sustain a population of arctic char. Further analyses of the hydrology of the affected water systems and mapping of spawning areas of arctic char are needed before a the impact of a hydropower plant on arctic char can be assessed in more detail.

Flora: several rare plant species located within the study area may potentially be affected by construction and operation of a hydropower plant. Especially the Paradise Valley is home to several rare species.

The flora in the affected area will be affected irrespective of location of the hydropower plant. However, detailed vegetation mapping prior to construction work will reduce potential conflicts between constructions and preservation of vegetation in the study area. With knowledge of the most important plant areas, these may hence be avoided during construction and operation of a hydropower plant.

Landscape: construction of a hydropower plant with associated transmission lines and infrastructure, and extensive mineral prospecting and exploitation will alter the landscape from pristine nature to a landscape impacted significantly by human activities. However, except for the transmission lines, most buildings and other technical elements may become more or less invisible in the large-scale Greenlandic landscape, e.g. when observed from a distance of few kilometres.

Additionally, there will be a significant impact from deposition of waste rock/rubble, and through altered silt flow into Søndre Strømfjord and Evighedsfjorden, where significant alterations in sedimentation and erosion will occur.

Surface waters, lakes, rivers and fiords: a southern hydropower plant at Evighedsfjorden will result in larger volumes of freshwater and silt being discharged into Evighedsfjorden, compared to the current situation where water and silt from Tasersiaq mainly is discharged into Søndre Strømfjord. Over time this may cause a disruption of the Sarfartoq delta in Søndre Strømfjord, and creation of a new or larger delta at Evighedsfjorden.

The part of the Sarfartoq River currently receiving silt from Tasersiaq will become less turbid and hence clear-watered, if a southern location of the power plant is chosen. This is, however, dependent on silt not being discharged into Sarfartoq from other water systems in the area.

Discharge of wastewater, percolate from waste areas, alteration of silt deposits, leaching of metals from deposited mine tailings and waste rock, and spills of environmental pollutants may combined result in considerable cumulative effects on the recipient water systems. The significance of this cumulative impact is dependent on the marine environment in the fiords and their robustness.

Culture and archaeology: construction of a hydropower plant and possible mineral exploitation will have significant impact on cultural remains in the area, since all remains located at construction sites of buildings and infrastructure, and in mining areas will be destroyed. Additionally, frequent traffic associated with construction activities, mineral exploitation, hunting and tourism will lead to increased wear and tear of the archaeological remains in the area.

Tourism, recreational activities and hunting: Construction of the hydropower plant will lead to increased accessibility to the area for tourists and hunters. Establishing an access road from Søndre Strømfjord to Tasersiaq will facilitate access to large areas towards the ice cap. This is positive for hunters in the area, since it will facilitate transportation of caribou and muskox carcasses. The area will also become more accessible for tourists, including hikers, trophy hunters and anglers. However, many tourists visit Greenland because of its pristine nature, and the construction of a hydropower plant with associated infrastructure and transmission lines will likely make the area less attractive from a tourist perspective.

1.4 Differences between alternative locations of hydropower plant

Several types of impact are identical for the two northern (07.e-1 and 07.e-4) and the southern (07.e-4) location of the hydropower plant, since they all three would use the same access road from the harbour planned at the mouth of the Sarfartoq River in Søndre Strømfjord.

The additional studies proposed in this report may confer novel knowledge identifying further significant differences between the three alternative locations. However, given current levels of knowledge there are the following marked differences between the two northern and the southern location (see Appendix 1).

The southern location will result in following positive effects:

1) Construction of transmission lines north of Sukkertoppen Iskappe is not needed, and the scenic value of the landscape north of Sukkertoppen Iskappe will hence remain relatively unimpaired compared to a northern location of the plant. Additionally, conflicts between transmission lines and caribou and muskox may be avoided, as well as the risk of collisions by white-fronted geese, since these species have their main distribution within the study area north of Sukkertoppen Iskappe.

2) Reduced silt levels in the Sarfartoq River may improve the habitat of arctic char, provided that the water levels in the river remain sufficient for spawning and dispersal of arctic char. Decreased silt levels in the Sarfartoq River may also affect harlequin ducks in the area positively.

The southern solution will result in following negative effects:

1) A hydropower plant at Evighedsfjorden may hinder the dispersal of muskoxen to the south.

2) Termination of the water flow from Tasersiaq to the Sarfartoq River may destroy plant communities with special flora associated with the river.

3) Increased shipping (including cruise ships) on Evighedsfjorden may result in disturbance of gull and auk breeding colonies in the fiord, and increase the risk of oil pollution near these colonies.

4) Oil spills caused by increased traffic on Evighedsfjorden may also have negative effects on capelin spawning sites.

5) Increased silt levels in Evighedsfjorden may affect unique marine environments in the fiord. However, it is currently unknown whether any unique marine environments exist in the fiord.

The northern solution will result in following positive effects:

1) Volumes of discharged water and silt into the fiords will remain relatively unaltered, resulting in preservation of the delta of the Sarfartoq River and the current marine environments.

Ved valg af en af de nordlige løsninger vil der være følgende negative effekter:

1) Området vil blive påvirket af et tungt landskabsteknisk element og deraf følgende landskabs-æstetiske påvirkninger.

Note that in relation to the proposed studies in section 3.1, new information may be obtained, which can lead to amendment of the current assessments given in this report.

2 INTRODUCTION TO THE HYDROPOWER PROJECT

The Greenland Home Rule has contracted an alliance with the American aluminium company Alcoa Inc. on the study of possibilities for constructing an aluminium plant with a production capacity of 340,000 tonnes per year.

The contract also includes studies of the basis for building and operating a series of auxiliary hydropower plants with associated infrastructure, harbours and transmission lines. Environmental and engineering assessments based on these studies will form the basis for final decisions regarding location of plants and other concrete aspects of the project.

If the project is implemented, construction of the hydropower plants is expected to begin in 2010, while construction of the aluminium plant is scheduled for 2012, and the aluminium plant will presumably be operative ultimo 2014.

Department of Environment and Nature, Greenland Home Rule, conducts a Strategic Environmental Assessment (SEA) of the alternative locations for the aluminium and hydropower plants. The SEA is divided into the four main themes, Environment and Nature, Culture, Health and Regional Development, respectively. This SEA covers the area West of Maniitsoq Iskappe between Nuuk and Sisimiut (see Appendix 2).

In September 2007, Grontmij | Carl Bro a/s was employed by the Department of Environment and Nature to conduct a preliminary cumulative assessment of the planned hydropower plant at Lake Tasersiaq and its impact on the area between Evighedsfjorden, Søndre Strømfjord and the Sarfartoq River (see Appendix 3). The aim of this assessment is to assess the cumulative impact of the hydropower plant and all other known and planned activities in the area, such as mineral exploitation and tourism, since the area is of great interest to operators of both these types of activities.

Following alternative locations for a hydropower plant at Lake Tasersiaq have been proposed (see Appendix 3). The locations are numbered according to the report of Nukissiorfiit on hydropower potential in Greenland.

1. Location in Sarfartoq Qoorua at the confluence between the Sarfartoq and Arnangarnup rivers (07.e-1).
2. Location in the Paradise Valley / Arnangarnup Qoorua (07.e-2).
3. Location at Ujaraannaq / Evighedsfjorden (07.e-3).
4. Location in Sarfartoq Qoorua west of location 07.e-1 (07.e-4).

The location 07.e-2 has been excluded by the Department of Environment and Nature due to its position in the protected Paradise Valley. The present assessments therefore only include the two northern locations at Sarfartoq Qoorua (07.e-1 and 07.e-4) and the southern location at Ujaraannaq / Evighedsfjorden (07.e-3).

According to the Greenland Home Rule a harbour is planned in Søndre Strømfjord at the mouth of the Sarfartoq River, and will be constructed independent of whether a northern or southern hydropower plant is chosen.

3 MATERIAL AND METHODS

Ideally, a cumulative SEA of the alternative locations of a hydropower plant should be based on final results, assessments and conclusions from the four SEA groups working with Environment and Nature, Culture, Health and Regional Development, respectively. However, due to the deadlines of the entire SEA process, the current cumulative assessment has been conducted in parallel with the work of the four SEA groups, from which the cumulative assessment has extracted data and partial assessments. Consequently, the cumulative SEA has been carried out not including all final data, conclusions and assessments from the four SEA work groups.

The assessments in the current cumulative analysis have been conducted on the basis of available literature, reports and GIS data. Additionally, to gain as much information as possible, a series of meetings were held with delegates from the Department of Environment and Nature, Department of Minerals, Department of Fisheries, Hunting and Agriculture, Department of Industry, Greenland Tourism and Business Council, Greenland Institute of Natural Resources, Asiaq a/s, Nukissiorfiit, Greenland Development, National Environmental Research Institute (NERI) and the National Museum.

Assessment of impact on animals and plants has been coordinated with NERI, the official advisory body to the Greenland Home Rule on natural resources, in order to ensure compliance with contemporary assessments by NERI. Likewise, assessment of potential human impact on archaeological remains has been sent to the Greenland National Museum for comments.

Current and future impact of a hydropower plant, mineral activities, hunting and tourism were assessed on the basis of available data. The analyses assessed the effects of these activities and their cumulative impact on nature, air, culture, archaeology, health, community, regional development and employment in the area.

Relevant parameters and assessed impact of the hydropower plant, mineral activities, hunting and tourism are given in Appendix 1, where the impact of the different human activities is assessed as: none (1), low (2), moderate (2) or significant (3). All parameters identified at risk of moderate to significant impact are discussed in the text together with possible mitigations.

Appendix 1 also contains an assessment of whether impacts differ between the northern and the southern location of the hydropower plant, and if impact is positive or negative for the relevant parameters. Additionally, the appendix lists the source of impact (hydropower plant, mineral activities, hunting or tourism), and whether the impact occurs during a construction and/or operation phase of a given activity (mainly hydropower and mineral activities). Finally, duration of impact, reversibility and whether the impact is direct or indirect are also indicated in Appendix 1.

Distribution maps of relevant parameters were constructed on the basis of available GIS data, and are given in Appendices 2-7.

3.1 Proposed studies and monitoring

During the present analysis, several cases of lack of sufficient data and need for further studies were identified. In a few cases, such data and studies may already exist, but due to the time constraints of the current analysis all available information from all institutions could not be obtained.

Based on the identification of lacking knowledge on specific subjects and parameters, suggestions for further studies are given in Appendix 8. Some of the proposed study activities are common practise during construction work in pristine nature. The proposed studies are each given an order of priority and estimates of expenses are given. The priorities and estimated expenses may be subject to changes, since additional knowledge and possibilities for coordinating different studies may influence the priorities given. Several of the listed studies include substantial budgets posts to cover expenses for transport and tracking devices. Therefore, e.g. current flight costs and the possibility of coordinating different studies may influence final prices considerably.

In Appendix 9, proposed monitoring programmes for the construction and operation phase of the hydropower plant are given. Monitoring programmes for mineral activities in the area will be more or less identical to those listed for the hydropower plant. It should be noted that the proposed monitoring programmes should be coordinated with already existing programmes and future monitoring activities in the area. However, such coordination is beyond the scope of the present report. Coordination with other monitoring programmes and additional knowledge obtained from other studies may change the described proposals for monitoring.

The frequency of each monitoring programme depends upon the results obtained during the preliminary studies. In some cases, monitoring will be irrelevant if the area turns out to be less important for a species or subject than previously expected. Therefore, the monitoring programmes should be planned on the basis of data and knowledge collected during the preliminary studies. In general, all relevant species/subjects should be monitored before and during construction of the hydropower plant, and subsequently each year in the first three years following construction. The need for continued monitoring should hereafter be evaluated.

4 LEGISLATIVE AND REGULATORY FRAMEWORK

Appendix 4 shows the study area with location of the protected Paradise Valley, important bird areas, concession areas for mineral activities (diamonds), areas with hunting regulations and potential areas for extraction of drinking water.

The following national legislations are relevant for current and future activities in the area of the cumulative assessment:

- The Landstings Act No. 6 of 19 December 1986 on area application and planning.
- The Landstings Act No. 12 of 22 December 1988 on protection of the environment with later revisions.
- The Landstings Act No. 4 of 3 November 1994 on protection of the marine environment with later revisions.
- Greenland Home Rule Executive Order no. 9 of 15 April 1993 on protection of freshwater resources and its reclamation for drinking water.
- Greenland Home Rule Executive Order no. 27 of 17 September 1993 on lavatories and disposal of latrine and wastewater.
- Greenland Home Rule Executive Order no. 29 of 17 September 1993 on disposal of garbage
- Greenland Home Rule Executive Order no. 29 of 17 September 1993 on oil and chemical waste products
- Greenland Home Rule Executive Order no. 11 of 20 August 2004 on environmental approval of particularly polluting industries.
- Landstings legislation no. 29 of 18 December 2003 on nature protection.
- Greenland Home Rule Executive Order no. 31 of 20 October 1989 on protection of Arnangarnup Qoorua, Maniitsoq Municipality, West Greenland
- Greenland Home Rule Executive Order no. 1 of 21 January 2004 concerning protection of birds
- The Greenland Home Rule Executive Order No.5 of 16 October 1980 on the protection of archaeological sites and buildings
- Legislation on mineral resources and regulations for prospecting etc.

Additionally, the following international conventions may be relevant with regard to current and future activities in the study area:

- Espoo convention on Environmental Impact Assessment and the protocol on Strategic Environmental Assessment
- The convention on Climate Change and the belonging Kyoto protocol
- Convention on Long-Range Transboundary Air Pollution
- The Basel convention
- The convention on Biodiversity
- The Ramsar convention
- European Convention on the protection of the archaeological heritage (revised)

There may also be plans and strategies within the framework of the Arctic Council, PAME, CAFF and the Nordic Council with respect to management, regulations and monitoring.

5 NATURE

5.1 Fauna

5.1.1 Mammals

The following five mammal species are found within the area of the planned hydropower plant: artic hare *Lepus arcticus*, arctic fox *Alopex lagopus*, caribou *Rangifer tarandus*, muskox *Ovibus moschatus* and harbour seal *Phoca vitulina*. Caribou and muskox are important hunting objects to both locals and tourists, while the harbour seal is endangered in Greenland. These three mammals therefore need particular attention with respect to their impact assessment, and will be treated individually in the following. Historical and current haul-out sites for harbour seal and observations of caribou within the study are shown in Appendix 5.

Caribou

Distribution and abundance

Caribou occurring within the study area are part of a regional population ranging between the Sukkertoppen Iskappe and Nordre Isortoq and has been estimated at 90,000 animals in the winter of 2005. Gestating females gather in local calving areas in May-June, and are during this period especially sensitive to disturbance. Calving areas usually constitute areas with advanced snow melting leaving early feeding opportunities for the caribou. Outside the calving season, caribou usually move over large areas in their search for food, and in some areas they undertake distinct foraging migrations. The caribou is an important hunting object and consequently receive considerable cultural recognition. The hunting free area within the study area is shown in Appendix 4, while observations of caribou during surveys conducted by NERI are illustrated in Appendix 5.

Impact and cumulative effects

As mentioned, the caribou are especially sensitive to disturbance within calving areas, which they typically occupy from 20 May to 20 June. Females with calves have thus been reported to leave their calving area due to human disturbance. Hydropower plant and mineral activities may both cause significant disturbance of the caribou due to construction of buildings and infrastructure, increased air traffic and associated hunting and recreational activities in the area. The construction of buildings and infrastructure may influence the distribution of caribou within the area. However, the animals may be expected to return to the area when construction activities cease, if human activities in the area remain scarce hereafter. Contrary, low flying air traffic, together with increased hunting and recreational activities within the area are expected to have long-term impacts on the caribou and their distribution.

Construction of transmission lines and establishment of harbour and roads within the area can potentially affect dispersal routes of the caribou.

The study area is situated in the southern part of the distribution range of the regional caribou population ranging between the Sukkertoppen Iskappe and Nordre Isortoq. Therefore, disturbance associated with increased human activity in the area will probably only affect a smaller part of the entire regional population.

Mitigations
Identify calving areas and avoid disturbance, such as construction work, within these areas from 20 May to 20 June. In case of frequent flying over calving areas or important foraging areas, fixed flying corridors avoiding these areas and regulation of flying altitude should be considered.

Construction of a road from Søndre Strømfjord to Tasersiaq will increase the accessibility of hunters and recreational activities in hitherto more or less undisturbed areas. This increased accessibility in combination with a large influx of workers during construction of a hydropower plant, may result in the need for regulation of traffic in important caribou areas. Hunting could be regulated with a hunting prohibition near the hydropower plant and along roads in the area, and if necessary with a quota system in the vicinity of the plant.

Lacking information and suggested studies

The distribution of calving areas within the study area is unknown, and should therefore be investigated. No standardised research on the reaction by caribou towards transmission lines and infrastructure has been conducted in the area. Such research should be undertaken if important areas for caribou are affected by these constructions. Additionally, it should be studied whether the local caribou population undertakes systematic long-range migrations that should be accounted for during construction of transmission lines, harbour and roads in the area.

Required monitoring
Survey caribou population size and caribou utilisation of the area during construction and operation of the hydropower plant.

Muskox

Distribution and abundance
The muskox was introduced to the area in 1962-65 when 27 muskoxen were translocated from Northeast Greenland to the vicinity of Kangerlussuaq. The population in Angujaartorfiup Nunaa has been estimated to 4236 muskoxen in 2004. Within their natural range in Northeast and East Greenland, females gather in special calving areas where the calves are born during May-June. However, there is no evidence that muskoxen within the study area utilise special calving areas. The introduced muskoxen in this area appear to give birth to their calves in whatever area they occupy during the calving season (15 April to 31 May).

Impacts and cumulative effects
In the calving season the muskox is especially sensitive to human disturbance, and a hydropower plant and mineral activities in the area can potentially cause disturbance due to construction of buildings and infrastructure, increased air traffic, hunting and other recreational activities associated with the increased human activity in the area. The current local hunting areas for muskox are shown in Appendix 7. Buildings and infrastructure will mainly cause disturbance of muskoxen during the construction phase, since the animals usually habituate to constructions if plant and immediate surroundings are not associated with hunting. Airplanes and helicopters flying at low altitudes together with hunting and other recreational activities may have long-term disturbing effects on muskoxen in the area.

Construction of transmission lines, harbour and roads may hinder the movements of muskoxen in the area. Hindrance of movements is not expected to play a significant role for a northern location of the power plant. However, a southern location may potentially hinder muskox dispersal to the south, since Ujaraannaq may serve as a southward dispersal corridor for muskoxen. Locating the hydropower plant at Evighedsfjorden may therefore potentially impact muskox dispersal negatively.

It has been suggested that disturbance of muskoxen, especially in the Paradise Valley, could affect the archaeological remains in the area positively, since it may prevent or lessen muskox grazing and trampling and hence decrease wear and tear and possible destruction of the remains. However, it would require continued disturbance to consistently keep muskoxen away from archaeological remains, and such continued disturbance will have considerable negative effects on other animal and plant species in the disturbed area, and will therefore be undesirable.

Considering the area's large current population size, the impact of a hydropower plant, mineral activities, hunting and tourism will probably have no long-term negative effects on the regional population of muskox.

Mitigation
Avoid frequent flying at low altitude over important staying and foraging areas of muskoxen.

Construction of a road from Søndre Strømfjord to Tasersiaq will increase the accessibility of currently more or less undisturbed areas. In combination with increased human activity, especially during the construction of a hydropower plant, this may result in the need for regulation of traffic in important muskox areas. The muskoxen were introduced to the area and currently show a positive population growth rate. How hunting of muskox is best managed in the area will depend on management goals in terms of future population dynamics.

If the hydropower plant is located at Evighedsfjorden, muskox dispersal along Ujaraannaq should be secured in order to not impair dispersal south, unless limitation of southern dispersal is desired.

Lacking information and suggested studies
Study whether muskoxen utilise Ujaraannaq as a dispersal corridor south.

Required monitoring
Survey muskox population size and its utilisation of the area during construction and operation of the hydropower plant.

Harbour seal

Distribution and abundance
The harbour seal has never been as abundant as other seals in Greenland, and is currently scarce in Greenlandic waters. The present population size of harbour seals is unknown, but the species is assumed to undergo a decline in several areas of its distribution in Greenland. It occupies fiords and coastal areas towards the north as far as Upernavik and Scoresbysund on the west and east coast, respectively. During summer harbour seals may enter rivers to forage for arctic char.

During summer harbour seals also utilise special haul-out sites to give birth and nurse the young (May-June), and for moulting (July-August). On these haul-out sites the seals are especially sensitive to disturbance. Previously, there has been a haul-out site within the study area at the mouth of the Sarfartoq River. The main reason for the seals abandoning this site is believed to have been hunting and extensive disturbance by boats.

Currently there is a haul-out area for harbour seal at the sand delta of the Watson River close to the Kangerlussuaq airport. The harbour seal thus still maintains presence in Søndre Strømfjord, and the previously used haul-out site at the mouth of the Sarfartoq River may potentially be utilised by the seals in the future, if left undisturbed. Known historical and current haul-out sites for harbour seal within the study area are shown in Appendix 5.

Impacts and cumulative effects
Increased boat traffic associated with both a hydropower plant and mineral activities in the area may lead to increased disturbance of harbour seals in Søndre Strømfjord, as well as to an increased risk of oil spills. A harbour at the Sarfartoq delta in Søndre Strømfjord will, especially during construction, result in increased disturbance in the area, and consequently hinder the seals from returning to this former haul-out site. Additionally, increased traffic on the fiord may lead to an increased hunting pressure on the harbour seals in the area.

Both a northern and southern hydropower plant will utilise the harbour being built at the Sarfartoq delta in Søndre Strømfjord, and both locations are therefore believed to have similar impact on harbour seals in the area. Increased hunting pressure due to more people and increased traffic on Søndre Strømfjord is assessed as the most significant impact on the harbour seals.

The discharge of silt from Tasersiaq into Søndre Strømfjord will cease if the power plant is located at Evighedsfjorden, and this may in the long run lead to disruption and disappearance of the delta at the mouth of Sarfartoq. Such disruption of the delta will impact the seals' utilisation of the area as a haul-out.

Mitigation
Protect haul-out sites against hunting and disturbance. Currently, the previously used haul-out site at the Sarfartoq delta is unoccupied by seals, but this site may become attractive to seals again if hunting and disturbance in the area are reduced. Regarding the harbour seal being a threatened species in Greenland, initiatives to reduce hunting and disturbance in the delta are desirable. Therefore, it is recommended that construction work at the harbour site should be conducted in September-April, when the seals are not occupying haul-out sites. Additionally, a hunting free zone in the harbour area could be introduced, in order to increase the chance that seals will habituate to the harbour.

Lacking information and suggested studies
The exact population size of harbour seal in Søndre Strømfjord is unknown, as well as the number of young produced each year. This should be estimated in order to assess the viability of the local population.

Required monitoring
Monitor the number and distribution of harbour seals before, during and after construction of the hydropower plant.

5.1.2 Birds

The following 28 bird species breed within the study area: great northern diver *Gavia immer*, red-throated diver *Gavia stellata*, great cormorant *Phalacrocorax carbo*, white-fronted goose *Anser albifrons*, Canada goose *Branta canadensis*, mallard *Anas platyrhynchos*, long-tailed duck *Clangula hyemalis*, harlequin duck *Histrionicus histrionicus*, red-breasted merganser *Mergus serrator*, peregrine falcon *Falco peregrinus*, gyrfalcon *Falco rusticolus*, white-tailed eagle *Haliaetus albicilla*, rock ptarmigan *Lagopus mutus*, common ringed plover *Charadrius hiaticula*, purple sandpiper *Calidris maritima*, red-necked phalarope *Phalaropus lobatus*, great black-backed gull *Larus marinus*, Iceland gull *Larus glaucoides*, glaucous gull *Larus hyperboreus*, kittiwake *Rissa tridactyla*, razorbill *Alca torda*, thick-billed murre *Uria lomvia* (in vicinity of the study area), black guillemot *Cephus grylle*, raven *Corvus corax*, northern wheatear *Oenanthe oenanthe*, redpoll *Carduelis flammea*, snow bunting *Plectophenax nivalis* and Lapland bunting *Calcarius lapponicus*. Of these 28 species only the geese, harlequin duck, the birds of prey, gulls and auks are evaluated as being impacted by the hydropower plant, and these species are therefore treated in the following.

Important bird areas within the study area are shown in Appendix 4, while observations of divers, white-fronted goose, Canada goose, harlequin duck, and seabird colonies are given in Appendix 6.

Great northern diver is “near threatened” according to the Greenlandic red list, and is hence included in Appendix 1. The main habitat of the great northern diver is clear watered lakes, where it hunts for arctic char. According to Appendix 1, the increased human activity associated with a hydropower plant will not impact the great northern diver significantly, and hence this species is excluded in the following assessment of impacts on birds.

Greenlandic white-fronted goose

Distribution and abundance
The Greenlandic white-fronted goose *Anser albifrons flaviostris* is an endemic subspecies only breeding in Greenland. Its breeding distribution is limited to West Greenland, where its breeding range extends from the region around Nuup Kangerlua/Godthåbsfjorden to the Upernavik district. Since the Greenland white-fronted goose only breeds in Greenland, the country is particularly responsible for its survival. Significant impact of a hydropower plant on the Greenlandic white-fronted goose should therefore be avoided.

The geese are most sensitive to disturbance when at their spring staging and moulting areas. The spring staging areas are places with advanced snow melting, allowing the geese to forage when they arrive form the wintering grounds. This early feeding is important for egg laying and incubation, since both processes are very energy demanding. Consequently, disturbance on staging areas, which the geese typically occupy from 1-20 May, may have a significant impact on their reproductive success. After the breeding season the geese moult their flight feathers, and consequently loose their ability to fly during this period (July). Moulting is also very energy demanding, and moulting areas must therefore supply plenty of nutritious food during the three to four weeks of moulting, as well as lakes and rivers where the geese can take refuge during disturbance. Disturbance during the breeding season caused by construction and operation of a hydropower plant is evaluated as non-significant for the Greenlandic white-fronted geese. The geese breed in single pairs scattered in the terrain, often several kilometers apart, and therefore, only a small part of the population will usually be affected by local disturbance during the breeding season.

Several important spring staging areas are located within the study area, but whether the geese utilise the area during moulting is not yet determined (see Appendix 6).

Impacts and cumulative effects
Based on current data, white-fronted geese seem to be most sensitive to disturbance in their spring staging areas. Disturbance may occur during construction and operation of a hydropower plant in the form of increased ground and air traffic, and increased recreational activities. The increased human activity related to the plant need to be considered together with mineral prospecting and exploitation in the area, since it is the cumulative effects of these activities that will impact the geese on their staging areas.

The proposed northern and southern locations of the hydropower plant are expected to have similar impact on the staging geese, since both locations are planned to utilise the same harbour and access road. Depending on the exact position of the transmission lines, they may potentially pose a collision risk for the white-fronted geese.

Mitigation
White-fronted geese have been shown to take flight/flee from hikers within a distance of 500 m, and to react towards low-flying helicopters within a distance of 2-9 km. These flight distances may be even larger during the moulting season, because the geese are more vigilant during this period of flightlessness. Therefore, it is important that both land and air traffic within the area maintain appropriate distance to staging and moulting geese. To minimise disturbance from helicopters and airplanes, fixed flying corridors avoiding important goose areas could be used.

Construction work related to the power plant should be conducted from early June to late April if planned near spring staging areas of white-fronted geese.

An information campaign on white-fronted geese, their utilisation of the area and their need for protection during staging and moulting, may reduce disturbance from increased recreational use of the area.

If important moulting areas are identified within the study area, construction work and other human activities should also be avoided near these sites in July.

The risk of geese colliding with transmission lines will be greatly reduced if lines are passed south from Tasersiaq, since the white-fronted geese mainly utilise areas north of Tasersiaq.

Lacking information and suggested studies
Surveys of possible moulting sites within the study area occupied in July are needed. These surveys could be complemented by behavioural studies of geese flight distances during different types of human activity. Such results can form a baseline for deciding minimum distances to staging and moulting geese in cases where human access near geese is unavoidable. After the moulting period the geese begin storing energy prior to their autumn migration. Whether the geese forage extensively in areas near a planned hydropower plant should be determined prior to construction.

Required monitoring
Monitor the reaction of geese towards human activities associated with construction and operation of the power plant.

Canada goose

Distribution and abundance

In recent years the Canada goose has expanded its breeding range in Greenland, and is at some localities on the West coast now more common than the white-fronted goose. Like the white-fronted goose, the Canada goose uses special spring staging areas and moulting areas, but whether the Canada geese stage during spring or moult after the breeding season within the study area is unknown. Observations of breeding Canada geese within the study area are shown in Appendix 6.

Impact and cumulative effects
Impact and cumulative effects are the same as described for the white-fronted goose. However, Canada geese arrive later in spring than white-fronted geese and consequently are sensitive to disturbance later in the season than the white-fronted geese.

Mitigation
See Greenlandic white-fronted goose.

Lacking information and suggested studies
It is uncertain whether Canada geese use the area for staging or moulting, and this should therefore be determined.

Required monitoring
Study reactions of the geese towards human activities in the area associated with construction and operation of the hydropower plant.

Harlequin duck

Distribution and abundance
Breeding harlequin ducks are scarce in Greenland, and the harlequin duck is red listed as “near threatened” in Greenland. Consequently, breeding harlequin ducks should receive special attention with respect to protection against human impact. They breed on the banks of rapidly streaming rivers in West Greenland south of Upernavik and in southeast Greenland. An aerial survey of breeding harlequin ducks was conducted in 2007 with transects at Tasersiaq, Ujaraannaq and the area north of Tasersiaq. However, no breeding ducks were encountered along any of these transects in 2007, but harlequin duck is believed to breed at the Arnangarnup River in the Paradise Valley (see Appendix 6).

Impacts and cumulative effects

The harlequin duck is sensitive to disturbance during the breeding season (June-September), particularly from traffic close to nesting sites and from low-flying airplanes and helicopters. A northern or southern hydropower plant will cause similar risks of disturbance at the presumed breeding site in the Paradise Valley, since both will make use of the same access road from a harbour at the mouth of Sarfartoq in Søndre Strømfjord. This road will increase the accessibility to the Paradise Valley, and thus potentially lead to increased traffic in areas suitable for harlequin ducks.

A southern power plant at Evighedsfjorden will lead to a more or less termination of silt discharge into Sarfartoq from Tasersiaq. This could potentially lead to increased numbers of harlequin ducks, since the entire river system (the Sarfartoq and Arnangarnup rivers) then will become clear-watered creating new potential breeding habitats.

Mitigation
Avoid low-flying air traffic over potential breeding areas, and regulate traffic by hikers near active nesting sites. This mitigation is, however, conditioned on the presence of breeding harlequin ducks within the study area.

Lacking information and suggested studies
The harlequin duck has not been confirmed breeding at the Arnangarnup River in the last few years. A thorough survey of breeding harlequin ducks at the Arnangarnup River should therefore be undertaken.

Assess whether a southern location of the hydropower plant will improve the habitat of harlequin ducks. The effect of less silt being discharged into the river should therefore be investigated. It should for instance be determined if a reduced silt content in the river automatically will lead to improved feeding conditions for harlequin ducks?

Required monitoring
If the harlequin duck breeds in the Paradise Valley, it should be monitored during construction and operation of the hydropower plant.

Birds of prey

Distribution and abundance
Three species of raptors breed in Greenland: white-tailed eagle, peregrine falcon and gyrfalcon. The white-tailed eagle usually prefers coastal areas with good prey availability in the form of fish and larger birds, but it also breeds within the study area of the cumulative assessment. The peregrine falcon is common within the area, while the breeding population of gyrfalcon is much smaller. The Greenlandic birds of prey all breed in eyries that are more or less inaccessible to humans.

Impacts and cumulative effects
Birds of prey are vulnerable to frequent human disturbance near eyries, and even apparently light disturbance may result in birds abandoning their nests.

Number of suitable eyries can be a limiting factor regulating the number of locally breeding birds. The raven prefers similar eyries as the birds of prey, and in some areas they thus compete for nesting sites, especially with falcons. The food availability of ravens within the study area will increase if an open waste dumb is established in association with the construction of the hydropower plant. Increased hunting activity may further leave more carcasses of caribou and muskox within the area, and consequently also increase the food availability for ravens. The number of breeding ravens in the study area is therefore expected to increase due to construction of a hydropower plant. This may increase the competition between ravens and raptors for nesting sites, and in the worst-case lead to a reduction of the number of breeding raptors within the area.

If positioning of harbour, access road and work camp are more or less identical in the alternative locations of the hydropower plant, then a northern and southern power plant will be expected to have similar impact on the birds of prey. In worst case, the increased human activity due to construction and operation of a hydropower plant, mineral prospecting and exploitation, increased hunting and tourism may lead to a reduction in raptor breeding numbers within the area. However, these activities are expected to result in low to moderate impact only, since relatively few breeding pairs will be affected relative to the large regional population of birds of prey.

Mitigation
Avoid frequent hiking and other human activities in the vicinity of known eyries during the breeding season.

All waste products should be collected and handled according to modern waste treatment technologies, and not just deposited at a waste dumb. This will limit the food availability of ravens, and such reduce the risk of competition for nesting sites between ravens and falcons. Compared to handling of waste products, limiting the number of carcasses in the area may prove more difficult, as this will only be attainable if hunters remove all remains from their kills. A possibility would be to perform organised hunting where the caribou or muskox are driven to particular areas with reasonable infrastructure to facilitate removal of carcasses after the animals have been shot.

Lacking information and suggested studies
The white-tailed eagle breeds within the study area, but exact locations of eyries are unknown, and should be identified. It is recommended to map the eyries of falcons in the areas impacted by the hydropower plant and associated infrastructure. This would facilitate mitigation at vulnerable eyries, and enable monitoring of competition for nesting sites between falcons and ravens.

Required monitoring
The population of breeding raptors in the vicinity of hydropower plant and associated infrastructure should be mapped, and its development during construction and operation of the power plant should be monitored.

Gulls and auks

Distribution and abundance
Four species of gulls (great black-backed gull, Iceland gull, glaucous gull and kittiwake) and three auks (razorbill, thick-billed murre and black guillemot) breed within the study area at Evighedsfjorden (see Appendix 6). The thick-billed murre breeds in the outskirts of the study area, but is included in the cumulative analysis since the Greenlandic population is declining, and Greenland has agreed to contribute to the monitoring and conservation of the arctic population of thick-billed murre. The population of kittiwakes within the study area is also vulnerable, since it is declining. A large part of the Greenlandic population (ca 1/3) breeds within the Maniitsoq municipality.

Impacts and cumulative effects

Breeding gulls and auks are very sensitive to disturbance at the breeding colonies, and even light disturbance may cause some individuals to abandon their breeding attempt. All shipping (including cruise ships and small boats) near breeding colonies may thus negatively impact breeding gulls and auks in Evighedsfjorden. Increased traffic on Evighedsfjorden is only expected if the southern location of the hydropower plant is chosen, since a northern power plant will not result in increased disturbance of gulls and auks in Evighedsfjorden.

The colonial gulls and auks are sensitive to oil spills near breeding colonies, which ultimately may extirpate large part of local populations. A hydropower plant, mineral activities and tourist ships may all potentially cause oil spills from ships, tanks, pipes etc. The risk of affecting colonial seabirds by oil pollution will be greatest if a southern power plant is chosen, since this will result in increased traffic on Evighedsfjorden. For a northern power plant any increased risk of oil spills will affect Søndre Strømfjord and adjacent water systems, where no breeding gulls or auks are found. However, risk of a major oil spill will presumably be low if international standards for shipping and current regulations for handling of oils at sea are adopted.

Mitigation
The breeding colonies of gulls and auks in Evighedsfjorden are currently protected against human disturbance, since hunting and other noisy behaviour are prohibited within 5 km from breeding thick-billed murres, razorbills and kittiwakes, and within 200 m from breeding black guillemots and all other gulls than the kittiwake. A hydropower plant at Evighedsfjorden and increased tourism on the fiord are, therefore, not expected to cause significant impact on gulls and auks in the area, as long as current regulations are followed.

To avoid oil spills near breeding colonies of seabirds, it is important that current regulations for handling of oils at sea are adopted.

Lacking information and suggested studies
None.

Required monitoring
Running monitoring programmes for the present gull and auk colonies are continued. Additional monitoring activities are relevant only in the case of Evighedsfjorden being affected.

5.1.3 Fish

Two species of freshwater fish, the three-spined stickleback *Gasterosteus aculeatus* and the arctic char *Salvelinus alpinus* inhabit the freshwater systems of the study area. None of these species is known to be threatened or have declining population sizes. Possible impact on arctic char is described in the following, since the arctic char is important both for local fishermen and as an object for angling tourism. No threatened or vulnerable marine fish species are found within the study area, but the capelin *Mallotus villosus* is relevant for the cumulative assessment because of its distribution in Evighedsfjorden and importance to local fishermen.

Arctic char

Distribution and abundance
The arctic char is common in rivers and lakes within the study area. It occurs in a residential form spending its entire life in freshwater, and in a migratory form, spending the first couple of years in freshwater followed by annual summer feeding migrations to the sea. The Arnangarnup River running through the Paradise Valley supports a large population of arctic char, which represents a significant fishery resource both to local fishermen and angling tourists.

Impact and cumulative effects
Pollution of rivers and fiords with wastewater from work camps associated with prospecting and exploitation presents a potential risk for populations of arctic char. However, granted responsible waste management is applied, the risk of severe negative effects from pollution on arctic char populations should be minimal.

Operation of heavy vehicles in riverbeds during e.g. road construction may create impassable obstructions to migrating char and to destruction of spawning sites.

Damming Lake Tasersiaq to create a water reservoir will alter water flow patterns in the Sarfartoq River. In case of a northern location for the hydropower plant, the water flow in the Sarfartoq River will be redirected from its present course and the water will instead either be led in headrace tunnels to a location at 07.e-1 or 07.e-4 (see Appendix 3), depending on location of the power plant. If the hydropower plant is constructed at a southern location on Evighedsfjorden, the water flow from Tasersiaq into the Sarfartoq River will cease. This will also result in termination of the discharge of silt into the river, and the entire river will therefore clear up, but maintain a reduced water flow. This may affect the river's arctic char population positively.

Changes to water levels in the Sarfartoq River will affect fauna and flora in the river. However, the magnitude of these effects and whether they will be positive or negative are not clear. The reduced water levels will presumably be sufficient for maintaining a viable population of arctic char, irrespective of location of the hydropower plan.

Mitigation

Modern sewage water treatment should be implemented during all phases of construction and operation of the hydropower plant, as well as for all mineral activities in the area in order to avoid wastewater pollution of rivers and fiords.

Obstruction or damming of rivers or streams in connection with building activities should be avoided or mitigated so as to always allow free passage for the arctic char.

In case important spawning sites are destroyed in connection with construction works, replacement spawning habitat should be created elsewhere and be accessible to the char.

Maintenance of a viable arctic char population requires that water levels are maintained above a minimum level year round. A minimum acceptable water threshold should therefore be established for the Sarfartoq River, and in case of risk of water levels dropping below this threshold, supplementation with water from Tasersiaq should be facilitated.

Lacking information and suggested studies

Minimum water levels required for maintaining an arctic char population in the Sarfartoq River must be determined and spawning sites should be mapped. For neither a northern, nor a southern hydropower plant location is it clear, how altered water flow patterns and water levels in the Sarfartoq River will affect the river's arctic char population. This should be investigated in order to assess the respective effects on arctic char in the Sarfartoq River.

Monitoring activities
Monitor arctic char population in the Sarfartoq River before and after construction of the hydropower plant. Monitor water levels in the Sarfartoq River to ensure constant maintenance of minimum water levels in the river.

Capelin

Distribution and abundance
Capelin is common and abundant in the Evighedsfjorden, and spawning sites occur within the investigated area. The species is an important functional component of the marine ecosystem, constituting an important food source for seals, seabirds and other fishes. Further, capelin is fished for local human consumption and for sleigh dog feed.

Impact and cumulative effects
Construction of a hydropower plant will presumably neither have positive nor negative effects on the distribution and abundance of capelin in the area. Increased traffic with ships and boats in association with tourism, building construction and potential prospecting activities in the Evighedsfjorden will nonetheless increase the risk of oil spills in the fiord. The capelin's eggs and larvae are sensitive to pollution from oil spills as they are spawned and feed in shallower waters. In case of an oil spill in the Evighedsfjorden, capelin spawning sites are hence likely to be particularly affected. However, risk of a major oil spill will presumably be low if international standards for shipping and current regulations for handling oils at sea are adopted.

Mitigation
To avoid oil spills associated with traffic on Evighedsfjorden current regulations for handling oils at sea should be pursued. In case of oil spills in the fiord known capelin spawning sites should be protected.

Lacking information and suggested studies
None.

Required monitoring
None.

5.1.4 Flora

Distribution and abundance
Several rare plant species found within the study area may potentially be affected by construction and operation of the hydropower plant. Particularly in the Paradise Valley numerous rare plants have been discovered (see Appendix 6). Among the rare plants recorded in Paradise Valley are: *Elymus violaceus*, *Braya linearis*, *Luzula groenlandica*, the hybrid x *Ledondendron vanhoeffeni* (endemic to Greenland), *Gentiana detonsa* and the endemic *Calamagrostris plonuninii*. An area north of Tasersiaq is an important location for the endemic grass *Calamagrostris plonuninii* as well as another rare grass *Calamagrostris lapponica*. The bay at Søndre Strømfjord west of Tasersuaq is home to the subspecies *Arctostaphylos uva-ursi spp. coactilis*, which only grows in this region of Greenland. This bay is also important for the Greenlandic population of *Myriophyllum spicatum*. Evighedsfjorden is one of the most important areas for the rare anemone *Anemone richardsonii,* and for the Greenlandic population of the subspecies *Orthilia secunda ssp. obtusata*.

Impacts and cumulative effects
Hydropower plant and mineral activities in the area may lead to destruction of plant habitats and associated rare plants due to construction of the hydropower plant, transmission lines and infrastructure. Additionally, permafrost breakdown/thermokarst and wind breaks caused by human activities associated with building and operation of hydropower plant and mineral exploitation may also degrade important botanical habitats. These activities may also alter the cover of snow in local areas due to factors like dust collecting on snow or snowdrift around roads, pipes etc. Such changes to local snow cover can influence plants in the area.

By altering the watercourse of the Sarfartoq River, as a result of constructing a reservoir for hydropower, plant communities associated with the river will be changed. This will be most marked if the power plant is located at Evighedsfjorden, as the water flow in the Sarfartoq River then will cease from Tasersiaq to the current confluence between the Sarfartoq and Arnangarnup rivers. Additionally, drainage of lakes during diamond exploitation will destroy associated aquatic plant communities.

The known important areas of rare plants within the study area (see Appendix 6) will neither be affected by construction and operation of a northern, nor a southern hydropower plant. Depending on where prospecting and exploitation of diamonds are going to occur within the area, these activities may potentially impact habitats with rare plants. However, impact on plant communities by a power plant or mineral activities can often be avoided through mitigations.

Mitigation
Detailed vegetation mapping prior to construction of buildings and infrastructure, like roads, airfields and a harbour may protect significant plant habitats against destruction. Careful planning can thus ensure that buildings and infrastructure are placed as appropriately as possible in relation to important plant areas. Several places within the study area consist of large dry or rocky areas more or less void of vegetation, where infrastructure and buildings may be constructed with no risk of harming rare plants.

Possible heavy traffic outside established roads in sensitive vegetation areas should be minimised and be planned during winter when the ground is frozen. Alternatively, helicopters or vehicles with special tires may be used during construction work in sensitive plant habitats, which would enable activities, also outside months of freezing.

Dust binder may be used on roads in order to avoid large deposits of dust on nearby vegetation and snow.

Important plant communities destroyed during drainage of lakes, as a result of diamond exploitation, can be re-established.

Lacking information and suggested studies
Vegetation mapping should be conducted in all areas where buildings and infrastructure are planned for either a hydropower plant or mineral activities prior to the onset of construction work. This may ensure protection of rare plant and important plant communities through careful planning of the construction work.

Identify areas with increased risks of permafrost breakdown in order to prevent such breakdown from occurring due to construction work in the area.

Required monitoring

Monitor rare plants within the study area during construction and operation of the hydropower plant in order to assess possible impact of human activity in the area.

5.2 Landscape

Existing conditions
The Greenlandic landscape is unique with huge areas of pristine nature unmarked by human activities. Among one of the most scenic landscapes within the study area is the protected Paradise Valley / Arnangarnup Qoorua (see Appendix 4). The Arnangarnup River runs through the valley and into the Sarfartoq River, which has its source at Lake Tasersiaq. Currently, tourist activities in and near the Paradise Valley are limited, but due to the valley's uniqueness plans of increasing tourism in the area are under development, with especially angling and hunting as attractive tourist activities. Different tourist operators may thus get concessions for different areas to run angling and hunting activities.

Diamond prospecting currently takes place within part of the study area, and concessions for future prospecting have been given in Angujaartoriup Nunaa and adjacent areas (see Appendix 4). Whether diamond exploitation is going to take place, and the scale of such exploitation, are currently unknown.

A harbour is planned for construction in Søndre Strømfjord at the mouth of the Sarfartoq River, independent of whether a northern or southern hydropower plant is chosen.

Impacts and cumulative effects
Hydropower plant: regardless of the location of the hydropower plant construction of buildings and infrastructure will lead to huge and permanent alterations of the landscape. The most significant impact will be evident during a construction phase, where the following activities will affect the landscape:

- Construction of buildings and infrastructure, including establishment of a work camp, harbour, roads, airfield, thermal power station etc.
- Construction of a reservoir / dams
- Construction of headrace tunnels from the reservoir
- Construction of a hydropower plant / turbines
- Construction of transmission lines
- Possible establishment of quarries / gravel pits for excavation of construction materials
- Possible deposition of rubble from constructing headrace tunnels, levelling of terrain, etc.

Direct impact from these activities include primarily blasting of rocks, levelling of terrain, excavation / breaking of materials and depositions of rubble. The impact of these activities will be significant and irreversible. The magnitude of the impact will, among other things, depend on the volumes of rock material blasted, reused and deposited.

Construction work will also result in a number of indirect effects on the landscape, such as alterations in water run-off with resulting increased erosion and permafrost breakdown caused by off-road traffic (see Appendix 1). These indirect effects are assessed as being non-significant compared to the direct impact on the landscape. However, local conditions, like distribution of permafrost, may alter the significance of indirect effects.

The most significant effects on the landscape during operation of a hydropower plant will be caused by:

- Altered discharge of silt into the fiords
- Deposition of silt excavated from the reservoir at Lake Tasersiaq
- Regulation of water levels in the reservoir at Lake Tasersiaq
- Increased wear and tear on terrain and vegetation from traffic

A southern location of the hydropower plant will result in large volumes of silt being flushed into Evighedsfjorden, where a new or larger delta may be formed. On the other hand, the delta of the Sarfartoq River in Søndre Strømfjord is likely to be gradually disrupted and likely disappear, since deposition of silt from Tasersiaq will cease in this location. The impact of altered silt deposits is difficult to assess, since it partially will depend on the volumes of silt discharged and conditions of the marine recipient.

Continuous excavation of silt deposits from the reservoir in Tasersiaq may be necessary, since the lake can be expected to gradually fill up with silt. The lake is recipient of large volumes of silt from the surrounding glaciers, and the longer retention time of water in the dammed reservoir may gradually cause increased silt sedimentation. The impact of the excavated silt is assessed as significant if the silt is deposited in the landscape. However, if the silt is removed form the area this will reduce the impact of silt excavation on the landscape considerably.

The shore of the reservoir at Tasersiaq will experience a continuous impact from changing water levels due to repeated regulation of water volume in the reservoir. During winter this may lead to breakdown of the shore, when sheets of ice near the edge of the lake are lowered.

Mineral activities: the current prospecting for diamonds is restricted locally and, hence, not assessed to have significant impact on the landscape. Future increased prospecting throughout larger areas will, however, magnify the impact, but effects are still expected to be relatively small and local. Likewise, wear and tear of the landscape due to prospecting of diamonds is assessed as non-significant.

If prospecting leads to exploitation of diamonds in the area, significant impact on the landscape may be expected. Breaking of rocks, drainage of lakes, depositions of waste rock/mine tailings, construction of infrastructure will, among other activities, affect the landscape significantly.

Hunting and tourism: greatly increased hunting and tourism will result in increased wear and tear of the landscape with an associated risk of erosion, thermokarst and wind breaks. However, the impact of hunting and tourism on the landscape are assessed to have low significance.

Cumulative effects: construction of a hydropower plant and exploitation of minerals have similar impact on the landscape, with the main cumulative impact of both activities being blasting of rocks, levelling of terrain, deposition of waste rock/rubble, and construction of buildings and infrastructure.

The impact on the landscape will be more or less similar for a northern and a southern hydropower plant location. The main differences between the alternative locations will be the volumes of rocks blasted, and where waste rock is deposited, which will depend on the terrain and exact position of the power plant.

Deposition of waste rock/rubble will be needed independent of the location of a power plant, since larger volumes of blasted rock will be produced than can be reused for construction materials etc. This deposition will be even more extensive if current prospecting results in exploitation of diamonds in the area. Waste rock/rubble from construction of a hydropower plant may potentially be subjected to geochemical analyses of interest to mineral prospecting activities.

Wear and tear on the terrain due to increased traffic (snow mobiles, ATVs, hikers) will be limited, but is likely to occur over wide expanses of area.

Mitigation
Cumulative impact on the landscape by construction of a hydropower plant and mineral activities can be minimised by joint use of infrastructure (harbour, roads etc.).

Part of the waste rock/rubble and excavated sand/gravel may be used for construction works (harbour, roads etc.), and consequently reduce the need for establishing quarries and gravel pits.

"Terrain models" can be used to manage volumes of handled rock material. Excess rock material should be deposited in the landscape where destruction of vegetation and other impairment of the landscape are minimal. Additional breaking of rocks and potential establishment of quarries or gravel pits should be carried out on locations where impact on the landscape can be minimised.

Redesign/reestablishment of landscapes can take place after termination of construction work, deposition of rock material or after ended excavation of sand/gravel.

Lacking information and suggested studies
Volumes of rock material to be broken, deposited or used for construction are currently unknown, but such calculations obviously should be included in the detailed planning of a hydropower plant.

To assess the impact of deposition/disposal of silt sedimentations from lake Tasersiaq, it is necessary to analyse the related volumes of silt and possibilities of disposal.

Estimate the quantities of silt being discharged into the fiords as a result of both a northern and southern location of the hydropower plant, and compare the results to current conditions. Importance of the changed silt conditions for formation and breakdown of river deltas, and its impact on the marine environment should also be evaluated.

The potential for excavation of sand and gravel within the study area is unknown, and identification of possible sites for quarries and gravel pits may therefore be needed. If rock, gravel and sand cannot be extracted from the local area, these materials will probably be transported into the area by ship, which may lead to increased risks of oil spills and disturbance on the fiords.

Information on soil conditions in potential construction areas is lacking, and the location of areas with increased risk of permafrost breakdown, thermokarst and erosion are also unknown. This will, however, be standard information gathered before construction of a hydropower plant in the area will commence.

Required monitoring
Monitoring of the extent of wear and tear, erosion, wind breaks, etc., should be performed, and the impact on the landscape recorded.

If excavation and deposition of silt from Tasersiaq is planned, the impact hereof on the landscape should be monitored. The silt will assumedly be deposited in the terrain, but if deposition is directed into the fiords, monitoring of the marine recipient should be considered.

5.3 Surface waters, lakes, rivers and fiords

Existing conditions
The Sarfartoq River has its source in the glacier lake Tasersiaq, and is therefore currently silty. On the way to its confluence with Søndre Strømfjord in a large delta, the Sarfartoq River receives the clear-watered Arnangarnup River. Lakes, rivers and fiords within the study area are currently not significantly impacted by human activities.

Impacts and cumulative effects
Hydropower plant: independent of its precise location, a hydropower plant with Tasersiaq as reservoir will cause alterations of the Sarfartoq River. The two northern locations (07.e-1 and 07.e-4) will result in less water and silt in the Sarfartoq River in a, respectively, shorter and longer section of the river. Depending on where the silty water running from Tasersiaq in headrace tunnels is discharged, a shorter or longer part of the Sarfartoq River will therefore become clear-watered.

Given a hydropower location at Evighedsfjorden (07.e-3) the water from Tasersiaq, currently flowing into the Sarfartoq River, will instead be lead into Evighedsfjorden. In this scenario large volumes of water will be redirected relative to the current situation, and substantial quantities of silt will be discharged into Evighedsfjorden from Tasersiaq (see Appendix 3). A southern power plant will thus result in the Sarfartoq River becoming clear-watered all the way to Søndre Strømfjord, but maintaining a lower water level since the previous water flow from Tasersiaq will cease. See also section 5.2 regarding the dynamics of river deltas in the area.

Both a northern and southern hydropower plant will thus lead to marked alterations of the Sarfartoq River, and consequently have significant impact on plants and animals associated with the river. Effects on marine environments from the alternative locations of the power plant have been impossible to assess, since the volumes of silt being discharged into (or remove from) the fiords are currently not estimated, and the marine environment(s) have not been described (including any presence of unique environments).

The above assessment of how the turbidity of the Sarfartoq River is likely to change in response to each potential power plant location, is conditioned on significant amounts of silt not being discharged into the Sarfartoq River from other sources than Tasersiaq.

During construction of the power plant wastewater from a work camp will be discharged into a recipient; probably Søndre Strømfjord or Evighedsfjorden. The discharge of wastewater will impact the recipient with nutritive substances and environmental pollutants from an estimated 2000 people. The impact of nutritive substances is assessed as highly significant, when such substances are discharged into an aquatic environment otherwise relatively low in nutrient minerals, and especially if unique marine environments in the fiords are affected.

Accidents with fuels and environmental pollutants may occur, resulting in pollution of freshwater systems and marine recipient. Such accidents may be rare, but can potentially have significant effects depending on the volumes leaked and the resilience of the recipient.

Mineral activities: mineral activities will mainly impact water systems during exploitation when wastewater may be discharged from a work camp, and accidents with fuels and environmental pollutants may leak into freshwater and marine environments. Additionally, diamond exploitation can directly influence lakes in the area, if they are drained as part of the exploitation.

Hunting and tourism: no significant impact from these activities is expected on the water systems in the area.

Cumulative effects: a hydropower plant and mineral activities combined will result in marked effects on the water systems in the area. The joint impact from discharge of wastewater, percolate from waste areas, alteration of silt deposits, leaching of metals from deposited mine tailings and waste rock, and spills of environmental pollutants may result in considerable cumulative effects on the recipient water systems. The significance of this cumulative impact is dependent on the marine environments in the fiords and their robustness.

Mitigation

The impact of discharged wastewater can be reduced by a wastewater treatment plant, and by discharging the treated wastewater into one or more robust recipients. Using fiords with frequent water renewal as recipient may dilute high concentrations of nutrients and environmental pollutants, and thus make suitable recipients. Additionally, the use of environmental pollutants should be minimised, and their disposal should be conducted correctly.

Lacking information and suggested studies

Alteration of the discharge of silt and water from Lake Tasersiaq may influence several parameters, such as arctic char, birds, landscape, the Sarfartoq River and marine environments in the fiords. Therefore, more information about the current volumes of water and silt discharged from Tasersiaq is needed, as well as estimates of future volumes discharged after construction of a hydropower plant.

The size of current silt volumes discharged into Evighedsfjorden relative to the additional volumes discharged from Lake Tasersiaq, if the power plant is located at Evighedsfjorden, is unknown. Likewise, it is unknown whether a considerable sedimentation of silt will occur in Tasersiaq due to a reduced water flow when the lake is dammed. The speed of silt sedimentation in the lake will be important to rates of continuous excavations of silt from the reservoir.

No knowledge exists on whether regulation of the water level in Tasersiaq will result in release of mercury from its banks.

The marine environments in Søndre Strømfjord and Evighedsfjorden have not been described, and potential impact of discharged silt and wastewater into the marine environments is unknown. Knowledge of marine environment in the two fiords, and possible existence of unique marine environments, are important for the assessment of impact from wastewater and altered discharge of silt into the fiords.

It should be identified whether Lake Tasersiaq potentially represents a scientifically important location for climate research. Relevant climatic research at Tasersiaq should be conducted prior to construction of dams at the lake, and before excavations disturbing deposited silt in the lake.

Required monitoring
Nutritive substances and environmental pollutants should be monitored in relevant recipients.

Leaching of metals from deposited waste rock and mine tailings, and its possible impact on the adjacent environment should be followed.

6 AIR

Existing conditions
Currently, no activities within the area contribute significantly to air pollution.

Impacts and cumulative effects
Hydropower plant: surplus energy from a hydropower plant may replace part of the current oil based energy production. Consequently, use of renewable energy sources from hydropower will result in reduced emissions of, for instance CO_2.

Use of the surplus energy is most relevant in relation to deliverance of renewable energy to Maniitsoq, since a hydropower plant is being produced in Sisimiut. Potentially, surplus energy may also be used by mineral activities or other local industries.

Mineral activities: an operating diamond mine in the area will result in dust and noise from breaking of rock materials, and emissions from traffic and production of heat/power for a work camp. These impacts are, however, assessed as non-significant.

Hunting and tourism: hunting and tourism in the area will probably not influence the air significantly.

Cumulative effects: no immediate cumulative effects have been identified.

Mitigation
Application of dust binder on roads may be used.

Lacking information and suggested studies
None.

Required monitoring
None.

7 CULTURE AND ARCHAEOLOGY

Existing conditions
The area Angujaartorfup Nunaa contains an important cultural heritage in the form of numerous archaeological remains, like cairns, tools and settlements. All archaeological remains dated prior to 1900 are protected according to the Greenland Home Rule Executive Order No.5 of 16 October 1980 on the protection of archaeological sites and buildings. Consequently, it is prohibited to disturb, destroy or remove protected remains in the area. The National Museum has for years, and latest in 2007, conducted surveys of the cultural heritage in and around Lake Tasersiaq. The distribution of known archaeological remains in the study area is shown in Appendix 7. Data from the latest survey in 2007 are, however, not included in this appendix.

Impacts and cumulative effects
Hydropower plant: construction of a hydropower plant will be concentrated in a relatively small area, but may anyhow lead to destruction of cultural remains due to large alterations of the landscape.

Deposits of silt excavated from Tasersiaq will demand large areas for deposition, if deposition on land is chosen, and consequently may cover and destroy archaeological remains in the affected area. Additionally, there will be a risk of archaeological remains being covered by silt blown from the deposits during dry periods.

The above mentioned, types of impact are all assessed as having significant effects on the cultural heritage in the area.

During operation of a hydropower plant impact on archaeological remains will mainly be due to ever changing water levels in the reservoir lake, which can cause destruction of organic material and removal of stones and archaeological remains from the banks of Tasersiaq.

By altering the watercourse of the Sarfartoq River some previously wet/moist areas will dry out with the risk of damaging associated archaeological remains. Such an impact would be more pronounced by a southern than a northern location of the power plant.

Mineral activities: impact of prospecting and exploitation of minerals will be comparable to impact of constructing a hydropower plant in the area, i.e. alteration of the landscape with resulting destruction of archaeological remains. Mineral activities may therefore also create significant impact on the local cultural heritage.

Hunting and tourism: frequent traffic due to increased hunting and tourism in the area may lead to wear and tear of archaeological remains, as well as impose a risk of increased collection of remains from the area.

Cumulative effects: impact on the cultural heritage from constructing a hydropower plant and mineral activities in the area will be significant, and can lead to destruction of numerous cultural remains in the landscape. Wear and tear from traffic (snow mobiles, ATVs and hikers) will be less significant, but occur over a larger area, including the protected Paradise Valley.

Mitigation

By taking locations of known archaeological remains into consideration during planning of the hydropower plant, destruction of important remains can be avoided by constructing buildings and infrastructure at appropriate distances from such remains.

Impact from hunting and tourism can be minimised by conducting information campaigns on the local cultural heritage and the need to preserve it. Possibly, restricted access to the most important cultural areas may be imposed.

Lacking information and suggested studies

Detailed mapping of archaeological remains, especially in areas designated for a hydropower plant and other human activities are needed. Additionally, a thorough investigation of the most important identified remains should be conducted.

Required monitoring

Monitoring of wear and tear and alterations of the most significant cultural remains within the area are needed.

8 HEALTH AND COMMUNITY

8.1 Health

Existing conditions
Currently, there are no permanent human settlements within the study area, but four settlements lie within a range of approximately 130 km, including Kangerlussuaq, Maniitsoq and Sisimiut. In these settlements energy for power and heating is oil-based. A hydropower plant is currently being constructed in Sisimiut.

Impacts and cumulative effects
Hydropower plant: an estimated 2000 workers will be employed during construction of a hydropower plant, and a work camp/settlement will be built. The influx of workers may have significant impact on the local society and its culture, depending on numbers of workers relative to the local population, and the workers' mobility. Such a relatively large immigration of, potentially short-term, workers may impose a stress factor on local society and its population. The impact of an increased population due to influx of workers will be similar for a northern and southern power plant.

Surplus energy produced by the hydropower plant can potentially substitute parts of oil based energy production in the region, resulting in reduced emissions and noise in areas where such substitution takes place.

Mineral activities: mineral activities will result in similar impact as described above for hydropower, with impact being associated mainly with exploitation of minerals within the study area.

Hunting and tourism: hunting and tourism will cause similar impact as that described for hydropower, just on a much smaller scale and at lower intensity.

Cumulative effects: evidence shows that a large influx of people may stress local communities and cause loss of indigenous culture. Impact on the local community will primarily be during construction of a hydropower plant, and to a lesser extent during mineral activities, which require a comparative smaller work force.

Mitigation

To reduce potential impact on the local community, limitation of access by workers in towns/settlements can be imposed. However, this may on the other hand lead to reduced income for local businesses like shops, service trades and tourist operators.

Lacking information and suggested studies
None.

Required monitoring
None.

8.2 Recreational activities and hunting

Existing conditions
Recreational activities like hunting and fishing are common within the study area, and holiday cottages exist on several localities in the vicinity of Kangerlussuaq. Caribou and muskox are the most attractive species for hunters, but hunting for seals, arctic fox, arctic hare and grouse also occurs. Fishery for arctic char, capelin, halibut and lumpsucker takes place in fiords, lakes and rivers of the area.

The Greenland Home Rule is currently producing a management plan for Kangerlussuaq, where hunting for caribou and muskox probably will be divided into commercial, recreational and trophy hunting imposed with separate designated areas and hunting periods.

Impacts and cumulative effects
Hydropower plant: construction of a hydropower plant and the associated infrastructure will increase access to recreational, hunting and fishing areas of interest for workers, tourists and locals. Due to the construction of new roads, the possibility for launching boats into Tasersiaq will also open up, making it feasible to penetrate deeply into formerly pristine nature.

The feasibility of building recreational cottages near an access road may lead to increased economical interest in constructing such cottages.

The hydropower plant will therefore have significant and positive effects for the possibilities of hunting, fishing and other recreational activities within the study area.

Mineral activities: mineral activities will have more or less similar impact as construction of a hydropower plant.

Hunting and tourism: a general increase in hunting and tourism within the study area may lead to conflicting interests between hunters and the tourism trade.

Cumulative effects: overall, an increased interest in hunting, recreational activities and establishment of recreational cottages may be expected within the area. This may be of immediate interest to the local population, foreign workers and tourists. With a common access road from a new harbour at Søndre Strømfjord to Tasersiaq, both a northern and southern hydropower plant are expected to have similar effects on the possibilities for recreational activities and hunting in the area.

Mitigation
Building of recreational cottages should be governed be regulations and central planning in order to prevent urban spread.

To reduce possible future conflicts between recreational activities and hunting within the area, central coordination and management of these activities should be conducted. To prevent over-exploitation of natural resources, e.g. caribou, muskox and arctic char by hunting and fishing, efficient government control of these activities is needed.

Lacking information and suggested studies
None.

Required monitoring
None.

9 REGIONAL DEVELOPMENT AND ENTERPRISES

9.1 Tourism

Existing conditions
Tourism in Greenland is currently experiencing a positive development, and the Greenland Home Rule is hoping to make tourism one of the main national enterprises together with mineral exploitation and commercial fishing.

Kangerlussuaq and its surrounding areas are important for tourism due to the many tourists passing through the Atlantic airport. Among the current tourist attractions are visits to the inland ice, caribou and muskox safaris, geology, hiking, hunting and angling.

The study area of the cumulative assessment is to some extent used for tourism activities, including trophy hunting.

A management plan for Kangerlussuaq and adjacent areas is on the way. Additionally, legislation regarding concessions of tourist activities with individual tour operators having access to specific areas for trophy hunting, angling etc. is under consideration. This may be of relevance for the study area; especially the Paradise Valley, with regard to trophy hunting and angling.

Impacts and cumulative effects
Hydropower plant: the plant and infrastructure will have a significant impact on the landscape, and following construction the area will no longer represent pristine nature. This may influence the perception of tourists to the area negatively (see also section 5.2).

Infrastructure associated with the hydropower plant will increase accessibility to previously more or less inaccessible areas, and thus facilitate the possibilities for tourism in the area.

Mineral activities: mineral activities will have more or less the same impact on tourism as construction of a hydropower plant.

Hunting and tourism: in case of increased hunting and tourism in the area, potential conflicts between the two activities may arise. The perception of wilderness and solitude will be reduced when more hunters and tourists are using the area.

Cumulative effects: the cumulative effect of a hydropower plant and mineral activities will markedly reduce the scenic value of the landscape, and may consequently have significant impact on tourism in the study area.

However, construction of infrastructure associated with the power plant and mineral activities will also have a positive effect on tourism, since it will increase the access to previously remote areas with potentials for tourism. Furthermore, the hydropower plant and possible diamond exploitation may become tourist attractions in their own right.

Mitigation
Plant, buildings and transmission lines can be architecturally adapted to the landscape in order to reduce their conspicuousness, and hence, at least from a distance, the perception of pristine wilderness can be retained.

Information material for tourists on the distribution of cultural remains, rare plants etc, and the need for their protection, should be produced.

Lacking information and suggested studies
Information on how far cruise ships pass into Evighedsfjorden was not available for the current assessment. Therefore, the impact of a hydropower plant, transmission lines and other planned constructions on the perception of tourists visiting the fiord by cruise ship is unknown. Locating a hydropower plant at Evighedsfjorden will result in more freshwater being discharged into the fiord. This may cause more ice formation and potentially impede the access of cruise ships in the fiord in winter.

Required monitoring
None.

9.2 Other enterprises

Existing conditions
A spring of freshwater has been identified at Evighedsfjorden (see Appendix 4), which potentially may be used for export of drinking water.

Experiments have been conducted with producing bricks from clay/silt extracted from the area around Kangerlussuaq.

Impacts and cumulative effects
Hydropower plant: the large influx of labour associated with construction of a hydropower plant can lead to increased trade and business locally, and potentially also result in increased price levels. Additionally, there will be a risk of scarcity of labour locally, if large proportions of local citizens are employed as labour for construction of the power plant.

Mineral activities: mineral activities will have similar impact to construction of a hydropower plant, but the impact will mainly be associated with the exploitation phase during which the need for labourers can be expected to increase.

Hunting and tourism: hunting and tourism may in their own right create more jobs and associated enterprises.

Cumulative effects: the mentioned impact will be even more pronounced if construction of a hydropower plant coincides with exploitation of minerals in the area.

Surplus energy from a hydropower plant may be used by mineral activities in the area, and possibly also facilitate establishment of other energy demanding industries, such as brick production based on local clay/silt concentrations.

Mitigation
None.

Lacking information and suggested studies
None.

Required monitoring
None.

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